Aerospace Engineering					
Course Description					
Aerospace Engineering (AE) is the study of the engineering discipline which develops new technologies for use in aviation, defense systems, and space exploration. The course explores the evolution of flight, flight fundamentals, navigation and control, aerospace materials, propulsion, space travel, orbital mechanics, ergonomics, remotely operated systems and related careers. In addition the course presents alternative applications for aerospace engineering concepts.					
Program of Study to which the course applies	**Course Code**				
STEM:	100164				
	Course Content	**Reference Standards**	**Academic Crosswalk to Common Core Standards**	**Academic Crosswalk to Nebraska Standards**	**Comments**
Standard 1	Students will understand the history of flight.	PLTW-AE			
Benchmark 1.1	Recognize knowledge of the history of flight enables an appreciation and understanding of past engineering accomplishments to be recognized.	PLTW-AE		SC.12.1.2.c	
Sample Performan	Identify the various vehicles used for human flight.	PLTW-AE			
Sample Performan	Identify and explain the function of the main components of an airplane.	PLTW-AE			
Benchmark 1.2	Knowledge of aerospace history provides insight to future challenges involving travel through the atmosphere and space.	PLTW-AE		SC.12.1.2.c SC.12.1.2.d	
Sample Performance Indicator 1.2.1	Identify the various vehicles used for human flight.	PLTW-AE			

Sample Performance Indicator 1.2.1	Identify and explain the function of the main components of an airplane.	PLTW-AE			
Benchmark 1.3	Understand many types of vehicles have been designed to fly.	PLTW-AE		SC.12.1.2.c SC.12.1.1.g	
Sample Performance Indicator 1.3.1	Evaluate and compare the effects of design changes on the performance of an airplane.	PLTW-AE			
Benchmark 1.4	Identify major components of airplanes, each of which has a specific function in the design and operation of the airplane.	PLTW-AE	ELA.RST.11-12.4	LA.12.1.5	
Sample Performance Indicator 1.4.1	Evaluate and compare the effects of design changes on the performance of an airplane.	PLTW-AE			
Benchmark 1.5	Describe how the forces acting on an aircraft enable it to fly.	PLTW-AE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a SC.12.1.1.g SC.12.2.2.a SC.12.2.2.d SC.12.2.2.e SC.12.2.2.f	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Sample Performance Indicator 1.5.1	Identify and explain the forces acting on an airplane.	PLTW-AE			
Sample Performance Indicator 1.5.2	Evaluate and compare the effects of design changes on the performance of an airplane.	PLTW-AE			
Sample Performance Indicator 1.5.3	Experience the flight characteristics of an airplane through the use of a flight simulator.	PLTW-AE			

Standard 2	Students will understand aerodynamics.	PLTW-AE			
Benchmark 2.1	Identify the forces applied to an airplane in flight: lift, weight, drag, and thrust.	PLTW-AE	ELA.RST.11-12.4	LA.12.1.5 SC.12.2.2.a SC.12.2.2.d SC.12.2.2.e SC.12.2.2.f	
Sample Performance Indicator 2.1.1	Identify the various forces acting on an airplane in flight.	PLTW-AE			
Sample Performance Indicator 2.1.2	Identify the various factors that affect the lift and drag forces generated by an airfoil.	PLTW-AE			
Benchmark 2.2	Describe how wings provide the lifting forces needed to overcome the weight of an airplane.	PLTW-AE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a SC.12.2.2.a SC.12.2.2.d SC.12.2.2.f	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Sample Performance Indicator 2.2.1	Identify the various forces acting on an airplane in flight.	PLTW-AE			
Sample Performance Indicator 2.2.2	Identify the various factors that affect the lift and drag forces generated by an airfoil.	PLTW-AE			
Sample Performance Indicator 2.2.2	Define the technical terms used to describe the geometry and performance of an airfoil.	PLTW-AE			
Benchmark 2.3	Engines provide the thrust force needed to overcome the aerodynamic drag from the body of an airplane.	PLTW-AE		SC.12.2.2.a SC.12.2.2.d SC.12.2.2.f	

Benchmark 2.4	The design of an aircraft wing requires knowledge of aerodynamics and physics.	PLTW-AE		SC.12.2.2.a SC.12.2.2.d SC.12.2.2.f	
Sample Performance Indicator 2.4.1	Analyze using a computer simulation tool the performance of an airfoil design.	PLTW-AE			
Benchmark 2.5	Understand the design process involves the use of computer simulation tools to predict the performance of a design prior to the building of a physical model.	PLTW-AE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.d	Alignment presumes that students will investigate computer simulation tools, analyze the tools, propose technical designs and evaluate the selected computer simulation designs (NE: SC.12.1.1.b, SC.12.1.1.d, SC.12.1.1.g, SC.12.1.3.a, SC.12.1.3.d).
Sample Performance Indicator 2.5.1	Analyze using a computer simulation tool the performance of an airfoil design.	PLTW-AE			
Sample Performance Indicator 2.5.1	Evaluate and compare using a computer simulation several airfoil designs.	PLTW-AE			
Sample Performance Indicator 2.5.1	Apply their knowledge of aerodynamics to design an airfoil that meets specifications.	PLTW-AE			
Benchmark 2.6	Understand the design process involves creating multiple solutions to a problem and then evaluating and ranking the solutions in order select the best solution.	PLTW-AE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d	
Sample Performance Indicator 2.6.1	Apply their knowledge of aerodynamics to design an airfoil that meets specifications.	PLTW-AE			
Standard 3	The students will understand airfoil construction.	PLTW-AE			

Benchmark 3.1	Verify design ideas through the construction and testing of prototypes and models.	PLTW-AE		MA.12.3.2.a MA.12.4.2.a SC.12.1.3.c SC.12.1.3.d	Alignment presumes that students will verify design ideas using quantitative data obtained through construction and testing of airfoil prototypes (NE: MA.12.3.2.a, MA.12.4.2.a).
Sample Performance Indicator 3.1.1	Extract geometric data from the FoilSim applet.	PLTW-AE			
Sample Performance Indicator 3.1.2	Use a spreadsheet application to scale the geometric data points extracted from FoilSim to define an airfoil with a given chord length.	PLTW-AE			
Benchmark 3.2	Sub-scale models are used to represent a full size system.	PLTW-AE	MTH.G.MG.1 MTH.G.MG.3	MA.12.2.4.b MA.12.2.5.b MA.12.3.2.a	
Sample Performance Indicator 3.2.1	Extract geometric data from the FoilSim applet.	PLTW-AE			
Sample Performance Indicator 3.2.2	Use a spreadsheet application to scale the geometric data points extracted from FoilSim to define an airfoil with a given chord length.	PLTW-AE			
Sample Performance Indicator 3.2.3	Use modeling software to design templates to be used for accurately cutting airfoil shapes from a foam core.	PLTW-AE			
Sample Performance Indicator 3.2.4	Evaluate different types of readily available foam products to determine the advantages and disadvantages of each in the construction of airfoil shapes.	PLTW-AE			

Benchmark 3.3	Coordinate geometry is used to create varied shapes, such as airfoils.	PLTW-AE	MTH.G.MG.3	MA.12.2.4.b	
Sample Performance Indicator 3.3.1	Use modeling software to design templates to be used for accurately cutting airfoil shapes from a foam core.	PLTW-AE			
Benchmark 3.4	Basic hand tools and equipment can be used to create accurate scale models.	PLTW-AE	MTH.G.MG.3	MA.12.2.4.b MA.12.2.5.b	
Sample Performance Indicator 3.4.1	Use modeling software to design templates to be used for accurately cutting airfoil shapes from a foam core.	PLTW-AE			
Sample Performance Indicator 3.4.2	Use appropriate tools and machines to safely and accurately construct an airfoil to be tested in a wind tunnel.	PLTW-AE			
Standard 4	Students will participate in wind tunnel testing.	PLTW-AE			
Benchmark 4.1	Testing prototypes is an important part of the design process.	PLTW-AE		SC.12.1.3.c SC.12.1.3.d	
Sample Performance Indicator 4.1.1	Identify the various components of a wind tunnel.	PLTW-AE			
Benchmark 4.2	Engineers use scaled models to evaluate, to test, and to determine the performance of their designs.	PLTW-AE		SC.12.1.3.c SC.12.1.3.d	
Sample Performance Indicator 4.2.1	Identify the various components of a wind tunnel.	PLTW-AE			
Sample Performance Indicator 4.2.2	Identify the various instruments used to measure the lift and drag forces generated by an airfoil.	PLTW-AE			

Sample Performance Indicator 4.2.3	Synthesize a test plan to measure the performance of an airfoil.	PLTW-AE			
Benchmark 4.3	Test results are best analyzed through the use of graphs and other methods to depict the data collected during the testing.	PLTW-AE	ELA.RST.11–12.7	LA.12.1.6.f MA.12.3.2.a SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d SC.12.1.3.e	Alignment presumes that students will model airfoil problems using graphs and other methods used to depict the data collected (NE: MA.12.3.2.a).
Sample Performance Indicator 4.3.1	Synthesize a test plan to measure the performance of an airfoil.	PLTW-AE			
Sample Performance Indicator 4.3.2	Measure the performance of an airfoil using lab equipment.	PLTW-AE			
Sample Performance Indicator 4.3.3	Analyze the performance data gathered during testing.	PLTW-AE			
Sample Performance Indicator 4.3.4	Evaluate and compare several performance characteristics of the airfoil.	PLTW-AE			
Sample Performance Indicator 4.3.5	Communicate their test results through a technical report and a presentation to the class.	PLTW-AE			
Standard 5	Students will be introduced to propulsion.	PLTW-AE			
Benchmark 5.1	Understand Newton's three Laws of Motion are central to the idea of propulsion.	PLTW-AE		SC.12.2.2.b SC.12.2.2.c SC.12.2.2.d SC.12.2.2.e	
Sample Performance Indicator 5.1.1	Learn about Newton's Three Laws of Motion and how they relate to propulsion.	PLTW-AE			

Benchmark 5.2	An external force is required to change the state of an object from rest to motion and from motion to rest.	PLTW-AE		SC.12.2.2.b	
Sample Performance Indicator 5.2.1	Learn about Newton's Three Laws of Motion and how they relate to propulsion.	PLTW-AE			
Sample Performance Indicator 5.2.2	Research and investigate propulsion and propulsion systems.	PLTW-AE			
Benchmark 5.3	Recognize the direction of acceleration is the same as the direction of the external force.	PLTW-AE		SC.12.2.2.c	
Sample Performance Indicator 5.3.1	Research and investigate propulsion and propulsion systems.	PLTW-AE			
Sample Performance Indicator 5.3.2	Identify the four main propulsion systems and the parts of an engine.	PLTW-AE			
Benchmark 5.4	Newton's Third Law of Motion can be used to explain the production of thrust by a propulsion system.	PLTW-AE	MTH.REI.3	MA.12.4.2.a SC.12.2.2.d SC.12.2.2.e	Alignment presumes that students will use calculations to conduct propulstion system analysis and analyze data sets using graphs (NE: MA.12.4.2.a)
Sample Performance Indicator 5.4.1	Identify the four main propulsion systems and the parts of an engine.	PLTW-AE			
Sample Performance Indicator 5.4.2	Conduct a propulsion systems analysis with calculations and graphs of data of various types of airplanes and propulsion systems.	PLTW-AE			
Benchmark 5.5	Identify the three principal propulsion systems are the propeller, the jet engine, and the rocket engine.	PLTW-AE	ELA.RST.11-12.4	LA.12.1.5	

Sample Performance Indicator 5.5.1	Conduct a propulsion systems analysis with calculations and graphs of data of various types of airplanes and propulsion systems.	PLTW-AE			
Sample Performance Indicator 5.5.2	Design an engine and test the design using Engine Simulation software.	PLTW-AE			
Sample Performance Indicator 5.5.3	Design, construct, and launch a water bottle rocket and make predictions of the rocket's altitude.	PLTW-AE			
Sample Performance Indicator 5.5.4	Calculate the average altitude and relate Newton's Three Laws of Motion to the height the rocket achieved.	PLTW-AE			
Standard 6	Students will demonstrate the ability to create a glider design, construction, and test.	PLTW-AE			
Benchmark 6.1	Aircraft designs are the result of the best available theories, knowledge, and skills available to the designer at the time of their creation.	PLTW-AE		SC.12.1.3.a	Alignment presumes that students will propose aircraft designs using technology and be able to explain how gravity and mass affect the ability of a glider to remain stable in flight (NE: SC.12.1.3.a, SC.12.2.2.f).
Sample Performance Indicator 6.1.1	Describe the requirements for a glider to remain stable in flight.	PLTW-AE			
Benchmark 6.2	Software utilizing the mathematics of flight theory can be used to predict the flight performance of an aircraft prior to its construction	PLTW-AE		SC.12.1.3.b	Alignment presumes that students will propose aircraft designs using technology and be able to explain how gravity and mass affect the ability of a glider to remain stable in flight (NE: SC.12.1.3.a, SC.12.2.2.f).
Sample Performance Indicator 6.2.1	Describe the requirements for a glider to remain stable in flight.	PLTW-AE			

Sample Performance Indicator 6.2.2	Utilize software to layout a glider that complies with characteristics provided by the instructor.	PLTW-AE			
Sample Performance Indicator 6.2.3	Design a glider for maximum flight distance.	PLTW-AE			
Benchmark 6.3	Construction of a multi-component device is aided by the use of assembly and alignment jigs.	PLTW-AE		SC.12.1.3.c	
Sample Performance Indicator 6.3.1	Construct a glider that accurately represents their design.	PLTW-AE			
Benchmark 6.4	Flight testing data is essential for evaluating an aircraft design.	PLTW-AE		SC.12.1.3.d	
Sample Performance Indicator 6.4.1	Summarize test data to identify the best glider design.	PLTW-AE			
Benchmark 6.5	Appreciate radically different designs can achieve similar results.	PLTW-AE		.SC.12.1.3.a	
Sample Performance Indicator 6.5.1	Write a proposal for “phase two” funding for a revised glider design.	PLTW-AE			
Standard 7	Students will be aware of GPS and Spatial	PLTW-AE			
Benchmark 7.1	Understand pilots need to know where they are and how to proceed to the next waypoint in their flight plan.	PLTW-AE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Sample Performance Indicator 7.1.1	Gain a familiarity with the evolving technology of aerial navigation.	PLTW-AE			
Benchmark 7.2	Recognize flight safety requires spatial awareness.	PLTW-AE			

Benchmark 7.3	Numerous methods have been used to communicate positional information to pilots using old, current, and cutting edge technology to improve flight safety through redundancy.	PLTW-AE		SC.12.1.1.f	Alignment presumes that students will review GPS data to measure locations of objects used to to communicate positional information to pilots (NE: SC.12.1.1.f).
Sample Performance Indicator 7.3.1	Use a GPS unit to measure the location of objects.	PLTW-AE			
Sample Performance Indicator 7.3.2	Summarize GPS data and create a navigational chart.	PLTW-AE			
Sample Performance Indicator 7.3.3	Explore the enhancements of the Wide Area Augmentation System (WAAS), Local Area Augmentation Systems (L.A.A.S.), and Synthetic Vision systems to the Global Positioning System.	PLTW-AE			
Benchmark 7.4	Describe how global Positioning Systems use information provided by a constellation of satellites to calculate a position and motion in all three axes and through time.	PLTW-AE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a MA.12.2.2.a SC.12.1.1.f	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a). Alignment presumes that students will review GPS data to measure locations of objects used to to communicate positional information to pilots (NE: SC.12.1.1.f).
Sample Performance Indicator 7.4.1	Use a GPS unit to measure the location of objects.	PLTW-AE			
Sample Performance Indicator 7.4.2	Summarize GPS data and create a navigational chart.	PLTW-AE			

Sample Performance Indicator 7.4.3	Plan a multi-segment flight through a simulated airspace.	PLTW-AE			
Sample Performance Indicator 7.4.4	Explore the enhancements of the Wide Area Augmentation System (WAAS), Local Area Augmentation Systems (L.A.A.S.), and Synthetic Vision systems to the Global Positioning System.	PLTW-AE			
Benchmark 7.5	Location and motion information is tremendously enhanced when it is correlated to 2D and 3D representations of the world around a pilot.	PLTW-AE			
Sample Performance Indicator 7.5.1	Plan a multi-segment flight through a simulated airspace.	PLTW-AE			
Sample Performance Indicator 7.5.2	Compare the ease of maintaining situational awareness using textual versus visual information when completing a “flight” through a simulated airspace.	PLTW-AE			
Standard 8	Students will understand how to measure rocket engine thrust.	PLTW-AE		SC.12.1.3.a	
Benchmark 8.1	Rocket thrust can be measured using a simple device.	PLTW-AE		SC.12.1.3.a	
Sample Performance Indicator 8.1.1	Design and build a rocket engine thrust testing device.	PLTW-AE			
Benchmark 8.2	Calibration of a thrust measurement device can provide accurate data.	PLTW-AE		SC.12.1.3.a	

Sample Performance Indicator 8.2.1	Design and build a rocket engine thrust testing device.	PLTW-AE			
Benchmark 8.3	Thrust vs. time data can be acquired using a strip chart recorder.	PLTW-AE		SC.12.1.1.e	
Sample Performance Indicator 8.3.1	Test the thrust of a model rocket engine.	PLTW-AE			
Benchmark 8.4	Rocket thrust must be controlled to reduce the damaging effects of traveling through dense atmosphere.	PLTW-AE		SC.12.1.1.e SC.12.1.1.f	Alignment presumes that students will collect and review thrust vs.time data using appropriate tools and technology to understand how to control rocket thrust during flight (NE: SC.12.1.1.e, SC.12.1.1.f)
Sample Performance Indicator 8.4.1	Modify the test to provide thrust vs. time data.	PLTW-AE			
Standard 9	Students will understand model rocket trajectory.	PLTW-AE			
Benchmark 9.1	Identify the parts of a model rocket and parts of a model rocket engine and describe the specific function(s) of each during a rocket's flight.	PLTW-AE	ELA.RST.11-12.4 ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.1.5 LA.12.2.1.b LA.12.3.1.a	When students describe information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Sample Performance Indicator 9.1.1	Define the terms and concepts of the design, flight, and forces on a model rocket and be able to explain how they interaction.	PLTW-AE			
Benchmark 9.2	Comprehend how the forces of weight, thrust, drag, and lift interact differently on a rocket in flight than on an aircraft in flight.	PLTW-AE		SC.12.2.2.a SC.12.2.2.b SC.12.2.2.c SC.12.2.2d SC.12.2.2.e SC.12.2.2.f	

Sample Performance Indicator 9.2.1	Investigate how changes in various design characteristics of a model rocket will affect the model rocket's flight performance.	PLTW-AE			
Benchmark 9.3	Newton's three laws of motion (inertia, F = ma, and action-reaction) can be used to describe and predict events during each phase of a rocket launch.	PLTW-AE		SC.12.2.2.b SC.12.2.2.c SC.12.2.2.d SC.12.2.2.e	
Sample Performance Indicator 9.3.1	Investigate how changes in various design characteristics of a model rocket will affect the model rocket's flight performance.	PLTW-AE			
Benchmark 9.4	Rocket design features are interrelated and determine how well a rocket will perform during powered flight.	PLTW-AE		SC.12.1.3.a	
Sample Performance Indicator 9.4.1	Work as an engineering team to construct a model rocket from a kit, fly it safely, and make predications, observations, and comparisons of flight data.	PLTW-AE		SC.12.1.1.a SC.12.1.1.b SC.12.1.1.c SC.12.1.1.d SC.12.1.1.e SC.12.1.1.f	
Benchmark 9.5	Calculate the maximum velocity and maximum acceleration of a rocket during flight, given model rocket and engine performance data.	PLTW-AE		MA.12.3.2.a MA.12.3.2.d SC.12.2.2.a SC.12.2.2.c SC.12.2.2.e SC.12.2.2.f	
Sample Performance Indicator 9.5.1	Use trigonometry to calculate an estimate for the maximum altitude a model rocket obtains during a launch.	PLTW-AE			

Sample Performance Indicator 9.5.2	Calculate a rocket's maximum velocity and maximum acceleration given rocket data and rocket engine performance specifications.	PLTW-AE			
Benchmark 9.6	Calculate a rocket's maximum altitude using indirect measurement.	PLTW-AE	MTH.A.CED.1 MTH.A.CED.2 MTH.A.CED.4 MTH.G.SRT.8	MA.12.3.2.a MA.12.3.2.d SC.12.2.2.a SC.12.2.2.c SC.12.2.2.e SC.12.2.2.f	
Sample Performance Indicator 9.6.1	Use trigonometry to calculate an estimate for the maximum altitude a model rocket obtains during a launch.	PLTW-AE			
Sample Performance Indicator 9.6.2	Calculate a rocket's maximum velocity and maximum acceleration given rocket data and rocket engine performance specifications.	PLTW-AE			
Standard 10	Students will understand a rocket camera.	PLTW-AE			
Benchmark 10.1	Use the Internet and the library to conduct research.	PLTW-AE	ELA.WHST.11-12.7-9	LA.12.1.6.j LA.12.4.1.a-c	The depth of students' investigations, and thus the research standards that apply, will be determined by the nature of the task (CC: ELA.WHST.11-12.7–9; NE: LA.12.1.6.j, LA.12.4.1.a–c).
Sample Performance Indicator 10.1.1	Use the Internet and the library to conduct research on the importance of aerial photography.	PLTW-AE			
Benchmark 10.2	Understand aerial photography has many applications.	PLTW-AE			

Sample Performance Indicator 10.2.1	Demonstrate an understanding of the scientific method by formulating a testable research question, and designing and conducting an aerial photography project/experiment.	PLTW-AE			
Benchmark 10.3	Using the scientific method to design a project to answer a research question is an important skill to conducting a scientific/engineering investigation.	PLTW-AE		SC.12.1.1.a SC.12.1.1.b	
Sample Performance Indicator 10.3.1	Calculate the scale factor of aerial photographs, and use the scale factor to determine the rocket's altitude when the photography was taken, and determine the length of objects in the photographs using the photograph's scale factor.	PLTW-AE			
Benchmark 10.4	Formulating a research question based on research, gathering data, analyzing data, and making judgments about experimental data are vital processes for conducting a research project/an investigation.	PLTW-AE	ELA.WHST.11-12.7-9	LA.12.1.6.j LA.12.4.1.a-c SC.12.1.1.a SC.12.1.1.b SC.12.1.1.c SC.12.1.1.d SC.12.1.1.e SC.12.1.1.f	The depth of students' investigations, and thus the research standards that apply, will be determined by the nature of the task (CC: ELA.WHST.11-12.7–9; NE: LA.12.1.6.j, LA.12.4.1.a–c).

Sample Performance Indicator 10.4.1	Calculate the scale factor of aerial photographs, and use the scale factor to determine the rocket's altitude when the photography was taken, and determine the length of objects in the photographs using the photograph's scale factor.	PLTW-AE			
Benchmark 10.5	The scale factor of aerial photographs can be used to determine a rocket's altitude, number, and kind of objects in the photograph, and the dimension of objects in the photographs.	PLTW-AE		MA.12.2.5.b MA.12.2.5.g	
Sample Performance Indicator 10.5.1	Calculate the scale factor of aerial photographs, and use the scale factor to determine the rocket's altitude when the photography was taken, and determine the length of objects in the photographs using the photograph's scale factor.	PLTW-AE			
Benchmark 10.6	Aerial photographs can be used to identify, classify, and enumerate objects in the photograph.	PLTW-AE			
Sample Performance Indicator 10.6.1	Describe how the launch angle relates to or affects the forces of lift, thrust, weight, and drag.	PLTW-AE			
Benchmark 10.7	A rocket's launch angle affects the forces of lift, thrust, weight, and drag.	PLTW-AE	MTH.N.VM.3	SC.12.2.2.f	

Sample Performance Indicator 10.7.1	Describe how the launch angle relates to or affects the forces of lift, thrust, weight, and drag.	PLTW-AE			
Standard 11	Students will understand orbital mechanics.	PLTW-AE			
Benchmark 11.1	Ellipses are conic sections, and circles are special cases of ellipses	PLTW-AE	MTH.G.MG.1	MA.12.2.2.a	
Sample Performance Indicator 11.1.1	Be able to define conic sections.	PLTW-AE			
Benchmark 11.2	Orbits involve the steady procession of a small mass object around a large mass object. This includes planets processing around the sun, as well as satellites processing around a planet.	PLTW-AE	MTH.G.MG.1	MA.12.2.2.a	Alignment presuems that studetns will research information about historical figures in orbit theory and describe difficulties experienced by these scientific innovators (NE: SC.12.1.2.d).
Sample Performance Indicator 11.2.1	Be able to define conic sections.	PLTW-AE			
Sample Performance Indicator 11.2.2	Learn about historical figures in orbit theory.	PLTW-AE			
Benchmark 11.3	Objects in orbit are continuously “falling” toward the body about around which they orbit.	PLTW-AE		SC.12.2.2.a SC.12.2.2.c SC.12.2.2.f	Alignment presumes that students will use appropriate tools to make qualitative and quantitative observations of the orbit theory in a laboratory exercise (NE.SC.12.1.1.e).
Sample Performance Indicator 11.3.1	Observe basic orbit theory through a laboratory exercise.	PLTW-AE			
Benchmark 11.4	Orbital elements can be used to fully define a satellite’s orbit, allowing the accurate prediction of the precise location of the satellite at a given time.	PLTW-AE		SC.12.2.2.a SC.12.2.2.c SC.12.2.2.f	Alignment presumes that students will use appropriate tools to make qualitative and quantitative observations of actual earth satellite motion to define a satellite's orbit (NE: SC.12.1.1.e).

Sample Performance Indicator 11.4.1	Learn about satellite motion and the application of orbit parameters by observing actual earth satellite motion.	PLTW-AE			
Benchmark 11.5	Orbital mechanics provides a means for describing orbital behavior of bodies.	PLTW-AE		SC.12.2.2.a SC.12.2.2.c SC.12.2.2.f	Alignment presumes that students will use appropriate tools to make qualitative and quantitative observations of actual earth satellite motion to define a satellite's orbit (NE: SC.12.1.1.e)
Sample Performance Indicator 11.5.1	Learn about satellite motion and the application of orbit parameters by observing actual earth satellite motion.	PLTW-AE			
Standard 12	Students will understand life support and environmental systems.	PLTW-AE			
Benchmark 12.1	Basic physiological needs of the human body when living safely within and outside of Earth’s atmosphere are oxygen, pressure, food and water, sleep, gravity, temperature, protective clothing, voiding by bladder and bowel.	PLTW-AE		MA.12.1.3.d SC.12.1.1.b	Alignment presumes that studetns will design and conduct experiments related to g-force to understand the effects of the Earth's atmosphere on human's physiological functions (NE: SC.12.1.1.b).
Sample Performance Indicator 12.1.1	Work cooperatively in a team to design and conduct experiments related to positive g-force.	PLTW-AE			
Benchmark 12.2	The environment on earth and in space must be considered when designing solutions to problems in aerospace engineering.	PLTW-AE		SC.12.1.3.a	Alignment presumes that students will design and conduct experiments related to designing solutions to problems in space (NE: SC.12.1.1.b).
Sample Performance Indicator 12.2.1	Safely conduct experiments and collect data.	PLTW-AE			

Benchmark 12.3	Engineers have solved many technological challenges faced when designing solutions for living higher atmospheres and space.	PLTW-AE		SC.12.1.3.d	Alignment presumes that students will analyze data and evaluate and technological solutions from experiments related to living in higher atmospheres in space (NE: SC.12.1.1.g)
Sample Performance Indicator 12.3.1	Analyze the results of experiments through careful observation of experiment videotape.	PLTW-AE			
Benchmark 12.4	The force, mass, and acceleration phenomena or G-forces that astronauts, fighter pilots, and Formula One drivers might experience is because of the rocket, jet, or internal combustion engine that provides the force needed to accelerate them, not gravity.	PLTW-AE		SC.12.2.2.a SC.12.2.2.f	
Sample Performance Indicator 12.4.1	Synthesize the data and apply experimental conclusions to real-world situations.	PLTW-AE			
Standard 13	Students will understand the effect of gravity on the human body.	PLTW-AE			
Benchmark 13.1	Reduced gravity environment scan be simulated in a 1-g, Earth-normal, environment.	PLTW-AE			
Sample Performance Indicator 13.1.1	Experience the feeling of vestibular stimulation.	PLTW-AE			
Benchmark 13.2	The action of spinning can fool the senses and stimulate the vestibular system in the inner ear.	PLTW-AE			
Sample Performance Indicator 13.2.1	Experience the feeling of vestibular stimulation.	PLTW-AE			

Sample Performance Indicator 13.2.2	Acquire data such as pulse rate and response time during stress tests performed in a reduced gravity environment.	PLTW-AE			
Benchmark 13.3	Describe how an increase stress-filled environment is physically unique and can affect the ability to perform mental functions.	PLTW-AE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a SC.12.3.1.d	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a). Alignment presumes that students will collect and analyze data on the effects of reduced gravity and vestibular stimulation on the human body (NE: SC.12.1.1.e, SC.12.3.1.d)
Sample Performance Indicator 13.3.1	Analyze data and draw conclusions regarding the effects of reduced gravity and vestibular stimulation on the human body.	PLTW-AE			
Benchmark 13.4	Cooperative and supportive team behaviors result in increased safety and higher quality data.	PLTW-AE	ELA.SL.11-12.1.b-d	LA.12.3.3	
Sample Performance Indicator 12.4.1	Research the effects gravity has on the body both in space and on earth.	PLTW-AE			
Standard 14	Students will understand microgravity drop tower.	PLTW-AE			
Benchmark 14.1	Gravity is the weakest force known in nature, yet it holds galaxies and the solar system together.	PLTW-AE			
Sample Performance Indicator 14.1.1	Show and describe the videotape of drop experiment.	PLTW-AE			

Benchmark 14.2	Any object in freefall experiences microgravity conditions, which occur when the object falls toward the Earth with an acceleration equal to that due to gravity alone (approximately 9.8 meters per second squared [m/s2], or 1 g at Earth's surface).	PLTW-AE		SC.12.1.1.g SC.12.2.2.f	
Sample Performance Indicator 14.2.1	Evaluate the results of the drop experiment with regard to anticipated outcomes.	PLTW-AE			
Sample Performance Indicator 14.2.2	Describe recommendations for modifying the experiment.	PLTW-AE			
Benchmark 14.3	Brief periods of microgravity can be achieved on Earth by dropping objects from tall structures.	PLTW-AE		SC.12.1.1.g SC.12.2.2.a	
Sample Performance Indicator 14.3.1	Evaluate the results of the drop experiment with regard to anticipated outcomes.	PLTW-AE			
Sample Performance Indicator 14.3.2	Describe recommendations for modifying the experiment.	PLTW-AE			
Benchmark 14.4	The microgravity environment associated with the space shuttle is a result of the spacecraft being in orbit, which is a state of continuous freefall around the Earth.	PLTW-AE		SC.12.1.1.g SC.12.2.2.a SC.12.2.2.f	
Sample Performance Indicator 12.4.1	Keep a journal, including a daily entry that explains what was done, what needs to be done and their results.	PLTW-AE			

Benchmark 14.5	A microgravity environment gives researchers a unique opportunity to isolate and study the influence of gravity on physical processes, as well as phenomena that are normally masked by gravity and thus difficult, if not impossible, to study on Earth.	PLTW-AE		SC.12.1.1.g	
Sample Performance Indicator 14.5.1	Keep a journal, including a daily entry that explains what was done, what needs to be done and their results.	PLTW-AE			
Standard 15	Students will understand composites fabrication and testing	PLTW-AE			
Benchmark 15.1	Multiple layers of any material are stronger than a single layer of that material.	PLTW-AE			
Sample Performance Indicator 15.1.1	Mold various composite materials into the standard size 1” x 12” test sample.	PLTW-AE			
Benchmark 15.2	Composite materials are fabricated by molding together layers of reinforced fabric, such as often glass or carbon fiber with a plastic matrix, such as epoxy.	PLTW-AE			
Sample Performance Indicator 15.2.1	Mold various composite materials into the standard size 1” x 12” test sample.	PLTW-AE			
Benchmark 15.3	Composite materials are used in the aerospace industry because they have excellent strength to weight ratios, which means they are able to carry large loads with a lighter structure.	PLTW-AE			

Sample Performance Indicator 15.3.1	Mold various composite materials into the standard size 1” x 12” test sample.	PLTW-AE			
Benchmark 15.4	The strength and stiffness of composite materials can be significantly increased by altering the distance between adjacent sheets using a core material to create a sandwich construction.	PLTW-AE		SC.12.1.1.b	Alignment presumes that students will design and conduct experiments related to testing the strength and stiffness of composite materials (NE: SC.12.1.1.b).
Sample Performance Indicator 15.4.1	Build a test jig to test each composite sample for deflection.	PLTW-AE			
Sample Performance Indicator 15.4.2	Conduct experiments and record data on the deflection of various composite samples using a micrometer and a dial indicator.	PLTW-AE			
Benchmark 15.5	Material performance is sometimes assessed by comparing strength to weight ratios.	PLTW-AE		SC.12.1.1.b	Alignment presumes that students will design and conduct experiments related to testing the strength and stiffness of composite materials (NE: SC.12.1.1.b).
Sample Performance Indicator 15.5.1	Build a test jig to test each composite sample for deflection.	PLTW-AE			
	Conduct experiments and record data on the deflection of various composite samples using a micrometer and a dial indicator.	PLTW-AE			

Benchmark 15.6	A deflection test can be used to accurately determine the modulus of elasticity of a composite plastic sample.	PLTW-AE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2 MA.12.4.2.a SC.12.1.1.b SC.12.1.1.f SC.12.1.1.g	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2). Alignment presumes that students will compare and graph data from deflection experiments (NE:MA.12.4.2.a). Alignment presumes that students will design and conduct experiments, collect and analyze data related to testing the strength and stiffness of composite materials (NE: SC.12.1.1.b, SC.12.1.1.f, SC.12.1.1.g).
Sample Performance Indicator 15.6.1	Conduct experiments and record data on the deflection of various composite samples using a micrometer and a dial indicator.	PLTW-AE			
Sample Performance Indicator 15.6.2	Analyze and graph the results of the deflection experiments.	PLTW-AE			
Benchmark 15.7	A deflection test can be used to indicate the stiffness of various composite plastic samples.	PLTW-AE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Sample Performance Indicator 15.7.1	Analyze and graph the results of the deflection experiments.	PLTW-AE			
Standard 16	Students will understand thermal protection systems for space vehicles	PLTW-AE			
Benchmark 16.1	An understanding of the physics of space vehicle re-entry into the atmosphere is important for designing thermal protection systems.	PLTW-AE			

Sample Performance Indicator 16.1.1	Identify the material properties that are necessary for an effective Thermal Protection Systems (TPS).	PLTW-AE			
Benchmark 16.2	Knowledge of material properties and testing is essential when trying to protect a space vehicle.	PLTW-AE			
Sample Performance Indicator 16.2.1	Identify the material properties that are necessary for an effective Thermal Protection Systems (TPS).	PLTW-AE			
Benchmark 16.3	Heat transfer is a process that creates high temperatures in a space vehicle.	PLTW-AE		SC.12.2.3.e	
Sample Performance Indicator 16.3.1	Identify the material properties that are necessary for an effective Thermal Protection Systems (TPS).	PLTW-AE			
Sample Performance Indicator 16.3.2	Describe the process of a space vehicle re-entry and the temperature extremes that a space vehicle may be subjected to.	PLTW-AE			
Benchmark 16.4	Energy is dissipated and converted into heat during a space vehicle re-entry.	PLTW-AE		SC.12.2.3.e	
Sample Performance Indicator 16.4.1	Describe the process of a space vehicle re-entry and the temperature extremes that a space vehicle may be subjected to.	PLTW-AE			
Sample Performance Indicator 16.4.2	Determine the thermal protection capability of several materials through tests of materials and related research.	PLTW-AE			

Sample Performance Indicator 16.4.3	Apply their knowledge of material properties to select the best candidate materials for use in a thermal protection system.	PLTW-AE			
Benchmark 16.5	Thermal Protection Systems (TPS) consist of various materials and coatings that are designed to protect a space vehicle.	PLTW-AE		SC.12.2.3.e	
Sample Performance Indicator 16.5.1	Determine the thermal protection capability of several materials through tests of materials and related research.	PLTW-AE			
Sample Performance Indicator 16.5.2	Evaluate and compare the thermal test results of several materials.	PLTW-AE			
Sample Performance Indicator 16.5.3	Apply their knowledge of material properties to select the best candidate materials for use in a thermal protection system.	PLTW-AE			
Standard 17	Students will have understanding of intelligent vehicles	PLTW-AE			
Benchmark 17.1	The two incentives for building robots are social, replacing humans in undesirable or dangerous jobs, and economic, reducing the cost of manufacturing while improving its quality.	PLTW-AE		SC.12.1.2.b	

Sample Performance Indicator 17.1.1	Design a computer driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.	PLTW-AE			
Benchmark 17.2	Interactive systems are used in complicated arenas, such as science exploration.	PLTW-AE			
Sample Performance Indicator 17.2.1	Design a computer driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.	PLTW-AE			
Benchmark 17.3	Electronic data communication allows information to be transferred from human to human, human to machine, machine to human, and machine-to-machine.	PLTW-AE			
Sample Performance Indicator 17.3.1	Design a computer driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.	PLTW-AE			
Benchmark 17.4	The determination of the pH (potential of Hydrogen) of an unknown substance or substances aids in identifying the substance.	PLTW-AE		SC.12.2.1.d	

Sample Performance Indicator 17.4.1	Design a computer driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.	PLTW-AE			
Benchmark 17.5	Robotic devices must be designed to perform effectively in the environment in which they will be used.	PLTW-AE			
Sample Performance Indicator 17.5.1	Develop a rubric that will be used to assess the design-build-operate criteria of the robot.	PLTW-AE			
Benchmark 17.6	Robotic devices are composed of mechanical, electrical, and computer based systems that can be programmed to make decisions and control actions based upon sensor readings.	PLTW-AE			
Sample Performance Indicator 17.6.1	Develop a rubric that will be used to assess the design-build-operate criteria of the robot.	PLTW-AE			
Benchmark 17.7	The fundamental challenge when working in robotics is deciding what motions the robot should perform in order to achieve a goal.	PLTW-AE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c	
Sample Performance Indicator 17.7.1	Design, build, and test an intelligent vehicle that will meet criteria determined by the goals established by the students.	PLTW-AE			